(taken every few minutes) should be made in different latitudes, to ascertain the apparent height to which these clouds attain. The determinations of azimuth and altitude should also be current to three or four minutes of arc, and the time to two or four minutes. Notice should also be taken of the general state of the atmosphere at the time of observation, while photography should be employed to record their place and motion. The paper contains one or two more suggestions, among which is the employment of the spectroscope, and concludes with the hope that the importance of this phenomenon in relation to cosmical problems will arouse much interest and enlist many observers, for, in such a case as this, the observations of one institution will not help to solve such a general question as this.

Nova Aurigæ.—From the communications, in *Astronomische Nachrichten*, No. 3120, we make the following notes with reference to the magnitude and spectroscopic appearance of the Nova Aurigæ.

Dr. J. Holetschek, of the Vienna Observatory, has examined the star with regard to the former, and finds that, if any, an increase in brightness has taken place since August 24. The following are his figures, N. standing for the Nova, and *a* a neighbouring star, the magnitude of which is taken as 9·7. The hours refer to Vienna mean time :—

1892.	h.	N.	m.
August 24	13¾	0·5*a*	9·65
,, 26	14	2*a*	9·5
,, 27	14	1·5*a*	9·55
,, 28	12¾	2·5*a*	9·45
,, 30	12¼	2*a*	9·5
Sept. 2	14	3*a*	9·4

Observations made on Sept. 15 12h., Sept. 16 11½h., and Sept. 17 12½h. showed that N. was at least four degrees brighter than *a*, and two degrees brighter than the star, 9·5m. B.D. + 30°·924.

Using the 30-inch of the Pulkova Observatory, Mr. A. Belopolsky has made some measurements of the brightest line visible in the spectrum. His measures are :—

1892.	W.L.	Mean.
September 10	501·2μμ	
,, 12	501·1	
,, 14	(499·5)	501·0
,, 15	500·9	
,, 16	500·7	

Of the other lines there were seen D or D_3, F, and a dark line about wave-length 465μμ.

Minor Planets.—The application of photography to the search of minor planets seems to be rewarded with remarkable success, for no less than four new ones, 1892, E, F, G, and H, have, since September 25, been discovered. The first two are due to M. Perrotin, while the last two were photographed by M. Wolf. A fact worth recording is that the plate, on which the latter planets were found, contained also two other images, those of the planets (34) Circe, and (184) Dejopeja ; thus the positions of four planets were obtained with one exposure.

Report of Mr. Tebbutt's Observatory.—In this small pamphlet we have a condensed account of the present state of the observatory buildings, instrumental equipment, &c., together with the work done during the year 1891. Although the staff is not very great, yet the work carried out shows that all the available time has been made the most of. The observations include forty-six occultations of stars by the moon, phenomena of Jupiter's satellites, transit of Mercury, conjunction of Venus and Jupiter, and filar micrometer comparisons of the minor planet Ceres, comprising 106 comparisons and four comparison stars. Several comets were observed with the square bar-micrometer, while some interesting double stars and the two variables of Argus and R. Carinæ have also been worked at. The 9h. a.m. meteorological observations have been continued with the usual regularity.

Photographic Chart of the Heavens.—In a paper read on July 1, 1891, before the Royal Society of New South Wales, Mr. H. C. Russell relates many of his experiences, together with some of the results obtained during the preparation of the Sydney Observatory for the photographic chart of the heavens. The first difficulty that turned up had reference to the photographing of the stars of the fourteenth magnitude. The two minutes' exposure was found quite long enough for ninth magnitude stars, but the thirty minutes was not sufficient to record those of the fourteenth. A question also arose as to coloured stars, for in many cases stars visible telescopically were not photographed at all. Of the many objects photographed with the portrait camera, Mr. Russell describes very fully the beautiful nebula 30 Doradus. This nebula, as he says, is a great spiral structure, of which we see the greatest diameter, its thickness measured through in the line of sight being comparatively small. He has been able also to obtain a very fine photograph of N. Argus, a nebula, which, as may be concluded from the negative, "covers a much larger area than that of Orion." The same photograph also confirms the observations made by Mr. Russell in 1872 that a conspicuous part of the nebula which Herschel drew and described in 1838 has wholly disappeared, and that its place is now occupied by a dark round spot. What this may be is a doubtful question, but as Mr. Russell says "It cannot be a solid body, because the stars are there, but a slight misty body would hide the nebula and not affect the stars very much." The pamphlet concludes with an excellent picture of the κ Crucis cluster.

GEOGRAPHICAL NOTES.

Colonel Bailey, R.E., lecturer on Forestry in the University of Edinburgh, has been appointed secretary to the Royal Scottish Geographical Society, in room of Mr. A. Silva White, whose resignation on account of ill-health we noticed some months ago.

Prof. Cherski, whose projected journey in Eastern Siberia was mentioned in Geographical Notes for June 30 (p. 212) is reported to have died near Sredne Kolymsk, on his way down the Kolyma river towards Nizhne Kolymsk, where he intended to have passed the winter. Cherski has travelled frequently and far in Siberia, and has done much to elucidate the geographical conditions, and in particular the geology of many parts of Northern Asia. His great geological map of the Lake Baikal district is the work by which he will be best remembered.

The current number of the *Scottish Geographical Magazine* contains Mrs. Bishop's account of her travels in Ladak and the adjacent territories, often called Lesser Tibet. As a record of personal adventure and observation of native character the paper ranks worthily with the published records of this traveller's earlier and later journeys.

The *Proceedings* of the Royal Geographical Society for October publishes a short statement of the progress of Indian surveys during the last field season. In Bengal the Behar detachment completed the traverse survey of 1610 square miles in districts Muzaffarpur and Champaran. In Bombay 2536 square miles of detailed survey were completed on the scale of two inches to one mile, and 2100 square miles were triangulated in the Gujarat and Mahratta country. Two parties were at work in Burma. In district Sagaing 1842 square miles of cadastral survey and 1142 of traverse survey were completed, while 700 square miles of traverse survey were made in district Shwebo, and a topographical survey, on the scale of one mile to an inch, of 106 square miles of the Chindwin coalfields. There were also carried out in districts Amherst, Tavoy, and Mergin 881 square miles of cadastral survey, besides a traverse survey of 510 square miles.

THE MICRO-ORGANISMS OF THE SOIL.[1]

THE high office with which you have honoured me entails the delivery of an address, which I keenly feel I cannot give in keeping with the standard set by my distinguished predecessors.

Fermentation, though observed since pre-historic times, is perhaps less understood than any chemistry has to deal with. The exciters of fermentation are rendered exceedingly difficult of investigation, because they, like all living things, are subject to physiological—or more specially pathological—functions of life ; they are so sensitive that any abnormal influence either changes their whole mode of existence or destroys it altogether ; a medium suitable to the life of one special kind is changed by it into a product which ceases to sustain it, but can nourish a lower class of organisms whereby concomitant fermentations arise, whose united effects are frequently such as to completely modify those produced by each separately; and for this reason have the specific actions of some ferments either totally escaped observation or have been misconstrued. Every succeeding year brings additional proof of the important rôle played by these minute organisms, and to such an extent, especially, has this been the case in connection with the rendition of available nitrogen, that there are good reasons to believe that a clearer comprehension of the action of soil ferments will dissipate all the anxiety chemists now entertain as to a gradual diminution of this so essential nutrient.

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[1] Address delivered by Prof. Alfred Springer as Vice-President of Section C. at the meeting of the American Association for the Advancement of Science.

To Hellriegel, Wilfarth, Wollny, Engelmann, Winograwdski, Warrington, and Heräus can be attributed the most noteworthy experiments in this special line. In order to appreciate the importance of their discoveries, I will, with your kind indulgence, first give a brief historical *résumé* of the study of fermentation. Owing to the extreme age of the use of alcoholic beverages, ferments entering into their production are best known, and this, added to the fact of their being larger and thus permitting of better examination, has been the determining cause of basing investigations and deductions upon their behaviour.

The very fact that the art of cultivating the vine and making wine is attributed by the Egyptians to Osiris, the Greeks to Bacchus, the Israelites to Noah—the brewing of beer to Gambrinus—shows how old these discoveries must have been. The effects of fermentation are sufficiently striking to have called the attention of primitive man to them. The ancient tribes of Asia and Africa understood how to ferment not only grape juice, but also to obtain alcoholic beverages from substances like starch, not directly fermentable. They used soured dough or beer-yeast as leaven for their bread, and knew how to prepare vinegar. The alchemists were wont to clothe their thoughts in such words as to make it difficult for us to decide what precise ideas they attached to the expressions of "Fermentation and Ferments" which are so frequently found in their writings of the thirteenth to the fifteenth century. They even speak of the philosopher's stone as fermenting unlimited quantities of lead and mercury into gold.

In the fifteenth century Basil Valentine in his "Triumphal Car of Antimony" claims that yeast employed in the preparation of beer communicates to the liquor an internal inflammation, thereby causing a purification and separation of the clear parts from those which are troubled; but considers alcohol as already existing in the decoction of germinated barley. In 1648 Van Helmont declared fermentation the cause of all chemical action and spontaneous generation, going so far as to give directions for the production of mice, frogs, eels, &c. He clearly observed the production of a special gas (gas vinorum) during alcoholic fermentation, and stated that something from the ferment passes into the fermentable substance, developing therein like a seed in the soil, thereby producing fermentation.

Willis, an English physician, in 1659 claimed that all functions of life depended upon fermentation, and that diseases were but abnormal fermentations. Both he and Stahl regarded a ferment as a body endowed with a motion peculiar to itself, which it imparts to the fermentable matter. Stahl in 1697 advanced the following theory: "Under the influence of the internal motion excited by the ferment, the heterogeneous particles are separated from each other, recombining so as to form more stable compounds, including the same principles but in different proportions. Putrefaction is but a particular case of fermentation." This theory remained unchallenged eighty years.

Lavoisier, by applying the new methods of organic analysis he had invented, quantitatively ascertained the relations between the fermented matter and the products.

Guy Lussac considered oxygen the sole cause of fermentation, putrefaction, and decay, by transmitting its motion to the ferment and this imparted its motion to the loosely combined fermentable mass.

The present theories of fermentation originated with Schwann and Pasteur. It took a century and a half before the experiments which led up to Schwann's theory found a scientific explanation by the work of this chemist. Leuwenhoeck had in 1680 already noticed that beer yeast was composed of small spheroid globules. Cagniard de Latour declared yeast a plant and the exciter of fermentation.

Schwann's experiments were made to determine the possibility of spontaneous generation. He found that fermentable fluids, when first heated in closed vessels in the presence of oxygen, to the temperature of boiling water would not ferment. This disproved Guy Lussac's theory that oxygen caused fermentation. He next showed that purified air or oxygen passed into a sterilized fermentable fluid did not induce fermentation; but that this set in with the introduction of ordinary air. He concluded from these experiments that the air was not the exciter, but simply the medium containing it, and that in the floating particles of the atmosphere were organisms capable of developing in the fluid; should these be killed by heat, fermentation would not take place. In his examination of these organisms, although his methods were not absolute, his conclusions that alcoholic ferments are of a vegetable nature were correct.

Instead of general acceptance, Schwann's theory received but little recognition.

Schultze's method of first passing the air entering a sterilized fermentable fluid through oil of vitriol, and that of Schroeder and Dusch of filtering it through cotton can be regarded as modifications of Schwann's experiments. All these experiments conclusively show that the particles in the atmosphere are the exciters of fermentation but do not render them visible.

Pasteur, spurred on by the same motive as Schwann—namely, to determine the question of spontaneous generation—made a simple modification of Schroeder and Dusch's experiment, by substituting gun-cotton, and achieved most remarkable results. The gun cotton, containing the particles filtered from the air, was dissolved in ether under the microscope, and now for the first time the organisms could be thoroughly examined.

Tyndall's well-known experiments, with the air-tight box coated with glycerine, demonstrated that gravity alone can purify the atmosphere so as to debar fermentation from setting in.

Pasteur's theory is that "The chemical act of fermentation is essentially a correlative phenomenon of a vital act beginning and ending with it; there is never an alcoholic fermentation without there being at the same time organization, development, multiplication of globules, or the continued consecutive life of globules already formed.

The following few examples will serve to show that the slightest changes in nutrients may render them worthless as such to certain ferments and available to others. Organic substances showing optical rotation chiefly exist already formed in the animal or vegetable organisms, or they can be easily obtained from such substances formed during vital processes.

When these substances are made synthetically, they are chemically and physically similar to the natural isomers, but usually do not rotate the plane of polarized light. This leads to the belief that these synthetical products consist of active and inactive molecules in such proportions as to neutralize each other.

Pasteur[1] verified his hypothesis by splitting inactive racemic acid into dextro-tartaric acid. Neutral ammonium racemate in a solution to which the proper inorganic salts had been added was fermented by means of *Penicillium glaucum* and beer yeast. The dextro-tartaric acid was consumed and the lævo left.

Lewkowitch[2] took inactive mandelate of ammonia, employing either *Penicillium glaucum* or *Bacterium termo*; in each case at the end of several weeks all the fluids showed more or less dextro rotation. Natural mandelic acid from amygdalin is lævo rotary, therefore here, as in Pasteur's experiment, with racemic acid it showed that the organisms consumed the naturally produced isomer.

Sac. ellipsoideus and split fungi consume the dextro and leave the lævo. The dextro has the same positive as the lævo negative rotation. The melting points and solubility of the right and left are the same, yet we see that these substances, chemically and physically the same, save in their opposite rotatory powers, can serve in one case as nutrients to certain organisms, and the other are worthless as such.

The Micro-Organisms of the Soil (*Sacchse*[3]).

These organisms, according to their actions, can be divided into three groups. Those oxidizing constituents of the soil those reducing or destroying the same; and lastly those by whose activity the soil is enriched. As regards the first group the oxidation can take place in two ways—they can either oxidize by assimilating the organic substances of the soil and reducing them to carbonic acid and water, in order to obtain the necessary heat and energy; or they can oxidize by giving off oxygen. The first may be termed intra-cellular, and the second extra-cellular acting organisms. Amongst the intra-cellular we have primarily, the usual ferments of decay, which assimilate and respire at the expense of the carbon compounds. In some cases the organisms have accommodated themselves to seemingly most remarkable materials for respiration, the combustion of which affords the necessary heat. Thus the Iron Bacteria of Winograwdski[1] require ferrous carbonate for their life and development, oxidizing the same to oxide. This can be physiologically interpreted as a respiration process, the protoxide of the respiration material becoming the oxide of respiration product.

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[1] Cr. xlvi. 615; li. 298.

[2] B. xvi. 1505, 1569.

[3] *Chem. Cent. Bl.*, 1889, vol. ii. 169, 225.

The Sulphur Bacteria are equally remarkable. Their cells are distinguishable by containing from time to time granules of amorphous sulphur. These organisms were formerly regarded as causing the formation of sulphuretted hydrogen in sulphur springs.

Winograwdski[2] claims the reverse to be the case. They do not produce sulphuretted hydrogen but consume it, burning it partially first to sulphur, which deposits in the cell water, then completely to sulphuric acid, which passes out and forms sulphates from the carbonates of the surrounding water. When no more carbonates are present, the combustion of sulphur to sulphuric acid ceases. Physiologically this is also a process of respiration directed towards generating heat and energy; sulphuretted hydrogen is the respiration material and sulphuric acid the respiration product.

(Olivier[3] does not agree with Winograwdski and De Rey Pailhade[4] claims the existence of a substance, philothion, in many plants and animal tissues capable of converting sulphur in the cold to sulphuretted hydrogen.)

Certain nitrification ferments can be regarded as intra-cellular. They may take up ammonia and give it off as nitrates, this process ceasing as in the case of the Sulphur Bacteria, when no more carbonates are present.

We now come to the discussion of two ferments, the concomitant actions of which have heretofore caused much confusion. Schloesing and Muntz were the first to observe nitrifying ferments, but to Warrington and Winograwdski belongs the credit of isolating the nitrous from the nitric ferment; furthermore, the striking discovery of a colourless organism, capable of existing and performing its functions, in a medium totally devoid of organic material, and synthetically producing organic bodies independent of sunlight. The importance of this discovery cannot be over-estimated.

Warrington[5] succeeded in obtaining organisms from meadow soil, cultivated in a solution of ammonium chloride and calcium carbonate, which oxidized ammonia to nitrous acid, but had no effect on nitrates. Assimilating the carbon of the carbon-dioxide, they require no organic substance for sustenance. They obtain from the oxidation heat of ammonia the necessary energy to dissociate the carbon-dioxide.

Winograwdski[6] obtained the same ferment employing 1 gr. ammonium sulphate, 1 grm. potassium phosphate dissolved in 1 litre Zurich water, to which he added basic magnesium carbonate. After inoculating the sterilized fluid with the nitrifying agent every trace of ammonia disappeared the fifteenth day. He describes this ferment as being an elongated ellipsoid, the smaller diameter 0·9 - 1 Mkr., the larger 1·1 – 1·8 Mkr. The organisms congregate about a piece of carbonate, cover it with their gelatinous mass, and as the carbonate disappears the cells take the shape thereof.

(Although the two investigators do not quite agree as to the morphological attributes of the ferment, Warrington arrived at the same conclusions as Winograwdski.)

Winograwdski[7] has at last succeeded in isolating the ferment which converts the nitrites into nitrates. He employed gelatinous hydrate of silica, impregnated it with a fluid containing the cultivated nitrous ferment. This medium was next inoculated with strongly nitrifying soil from Quito; shortly afterwards two different organisms formed respective colonies, one of these was the one sought for. It was composed of irregularly shaped rods, dissimilar to the nitrous ferment of the same soil. He has since found this ferment in many other soils; it is capable of converting solutions of nitrites into nitrates.

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[1] *Bot Ztg.*, xlvi. 261.
[2] *Bot. Ztg.*, xlv. 489, 513, 545, 569, 585.
[3] Cr. cvi. 1744.
[4] Cr. cvi. 1683; cvii. 43.
[5] *Chem. News*, lxiii. 296.
[6] A. J. P., September 1890.
[7] A. J. P., v. 577; Cr. cxiii. 89.

Strange to say the isolated ferment from Quito does not oxidize ammonia; it produced neither nitrites nor nitrates when sowed in ammoniacal fluids, easily nitrified by the nitrous ferment.

In normal soils the nitrate ferment only produces nitrates even in the presence of a large quantity of ammonia, which does not retard the oxidation of the nitrites immediately after their formation.

Muntz[1] claims the existence of an ammoniacal ferment in the soil which converts organic nitrogen into ammonia, preparatory to nitrification.

Extra-Cellular Oxidation.

In order to oxidize outside of the organisms, oxygen must be evolved by an assimilation process. Assimilation as an oxidizing cause, for conditions prevailing in the soil, has heretofore received no significance, since the evolution of oxygen, according to the generally accepted theories, depended upon light and chlorophyll, consequently the produced oxidation could only occur on the extreme outer surface. An exception to this heretofore unrestricted rule has been found by Engelmann as well as one by Heräus. According to Engelmann,[2] Bacterium photometricum sharply discriminates between lights of different intensity and wave lengths. The influence of light upon the bacteria is directly proportionate to the intensity. When the intensity is suddenly decreased, the bacteria shoot backwards with opposite rotation (the author calling this a terror motion), consequently a well-defined illuminated spot in an otherwise dark drop serves as a trap for these bacteria. They cannot leave, since the terror motion causes them to move back into the illuminated field as soon as they come to the dark outline.

The mobile forms principally congregate in the ultra red rays, *i.e.* physiologically in darkness, and in them as in the visible parts of the spectrum in places closely corresponding to the absorption bands of bacteriopurpurin. This constant ratio between absorption and photokinetic action clearly indicates that the prime effect of light is equivalent to the carbon-dioxide dissociating processes of plants containing chlorophyll.

The bacteriopurpurin is a true chromophyll, inasmuch as it converts the actually absorbed energy of light into potential chemical energy. When lights of different colour were employed, the evolution of oxygen increased with the absorption of light by the Purple bacteria. This shows that the power of developing oxygen is not the specific property of a certain colouring matter, as these organisms contain no chlorophyll.

It is not surprising, therefore, that other organisms, either coloured or uncoloured, be found to possess the property of assimilating carbon in the absence of light and evolving oxygen. Such a discovery has now been made—Hueppe[3] substantiating a communication from Heräus that certain colourless bacteria produce from humus and carbonates, in the absence of light, a body closely resembling cellulose. Oxygen is liberated, but remains unobserved, as it is immediately used to oxidize the ammonia to nitric acid.

The next question is: To which extent do the oxidizing organisms partake in the oxidation phenomena actually taking place in the soil? According to E. Wollny[4] the oxidation of carbon-dioxide is almost completely to be attributed to the activity of small organisms, of which Adametz[5] estimated that there are about 500,000 to 1 gr. soil. As in all such experiments, this conclusion is based upon the fact that no evolution of carbon-dioxide takes place, or is forced to a minimum, in a sterilized soil under otherwise favourable conditions.

Liberation of Combined Nitrogen.

This may take place during putrefaction under the greatest possible exclusion of oxygen, or during decay in the presence of oxygen. It does not necessarily occur in all cases, or may not be observed owing to a reverse concomitant process, *i.e.*, the fixation of nitrogen. Nitrogen losses can be expected during decay, on account of the action of the produced nitrous acid upon the amidlike dissociation of humous bodies, as well as in the formation of easily dissociable ammonium nitrites. A peculiar case of the disappearance of available nitrogen exists in the reduction of nitrates, as noticed by Springer,[6] Gayon and Dupetit,[7] and Deherain and Marquenne.[8]

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[1] Cr. cx. 1206.
[2] *Bot. Ztg.*, xlvi. 661, 677, 693, 709.
[3] Ntf. Vers., lx.
[4] LV. St., xxxvi. 197.
[5] Inaug. Diss., Leipsic, 1886.
[6] *Amer. Chem. Jour.*, iv. 452–53.
[7] Cr. xcv. 644.
[8] Bot., vii. 138.

Organisms by whose Activity the Soil is Enriched in Nitrogen.

A distinction must be drawn between the higher and lower plants. It is a well-known fact that most plants cannot assimilate free nitrogen; whereas there are sound reasons for the belief that the legumes are exceptions to this rule. The explanation has been sought in the tubercles. These tubercles contain a tissue, consisting of thin-walled cells filled with an albuminous substance, consequently they are richer in nitrogen than the roots; they have been regarded by some as pathogenic growths, by others as reserve reservoirs for albumin. We may now conscientiously assume that these tubercles arise through exterior infection, and that they are not normal growths.

Hellriegel and Wilfarth,[1] in their great work, state:—"The legumes deport themselves quite differently from the non-leguminous plants respecting the assimilation of nitrogen, whereas the latter are totally dependent for their nitrogen needs upon the nitrogen compounds present in the soil, and their development proportional to such disposable supply. The legumes have, besides, the soil nitrogen, a second source, from which they can abundantly cover any deficiency existing in the first. This second source is free atmospheric nitrogen. The legumes attain this power by the co-operation of active living micro-organisms. The mere presence of low organisms in the soil does not suffice to make the free nitrogen serviceable, but it is necessary that certain kinds of organisms enter into a symbiotic relationship with the legumes.

Lupines acquire nitrogen like the other legumes. They starve in a soil free from nitrogen when the presence of low organisms is excluded; but when this is not the case their growth is normal. The experiments were carried on in sand containing a suitable nutritive solution. Some of the pots were sterilized; to some infusions from soil were added. In all and in only those, to which fresh infusions of lupine soil had been added the lupines developed normally bearing the well-known tubercles on their roots, and contained, when harvested, conspicuously larger amounts of nitrogen than the soil and infusion could have given them. Wherever the infusion had not been added, or where it had been sterilized at 100 or even 70, the development remained abnormal, the production scant; tubercles remained absent and the harvested plants contained less nitrogen than had been offered them.

According to Ward,[2] Breal,[3] and Pradmowski,[4] tubercles will grow on plants free from them when infected with an infusion from tubercles of other plants.

Beyrenick[5] has named the infecting organisms, of which there may be many varieties, Bacterium Radicola. With the growth of the tubercles the behaviour of the plant towards nitrogen is changed, and the just mentioned independence begins; this has been proved by an almost superabundance of experiments. Still the explanation of the manner in which the nitrogen is acquired is not definitely settled. The first inference would be that the root-inhabiting bacteria possess the power of assimilating atmospheric nitrogen, and the higher plants as hosts harbouring these bacteria in their roots, use the nitrogen compounds so produced. Thus there would exist a case of symbiosis between Split Fungi and the higher plants. We cannot be too slow in accepting this seemingly simple explanation—still the difficulty of a correct interpretation does not alter the fact that the legumes acquire free nitrogen from the atmosphere, and that the refuse of their roots thus enrich the soil. They may be called nitrogen collectors in contradistinction to the graminaceous nitrogen consumers.

Berthelot[6] has long contended that the free soil can fixate nitrogen; he considers a sandy and clayey nature of the soil essential, it must admit of free access of air, must not be too moist, be rich in potash and poor in nitrogen. Gautier and Drouin[7] claim that the presence of humous substances causes increase of nitrogen.

Soils free from organic substances do not fixate nitrogen, or the gain is slight. The presence of ferric oxide so long considered capable of fixing nitrogen, has no effect. Berthelot, as well as most investigators in this line, attribute the fixation to the activity of nitrogen fixing chlorophyll free bacteria. In most cases the amount is much less than that obtained in soils with legumes. No inorganic soil constituents are known to possess the power of fixing nitrogen, and it is questionable whether humous substances can directly do this.

In 1881 Atwater claimed that peas during their growth obtained large quantities of nitrogen from the air. Atwater[1] and Woods made another series of eighty-nine experiments; the result will be found in their admirable paper in the American journal. I will quote the following: "There was in no case any large gain without root tubercles; but with them there was uniformly more or less gain of nitrogen from the air. As a rule, the greater the abundance of root tubercles, the larger and more vigorous were the plants, and the greater was the amount of atmospheric nitrogen acquired. The connection between the root tubercles and the acquisition of nitrogen, which was first pointed out by Hellriegel, is abundantly confirmed. In a number of these experiments, there was a loss of nitrogen instead of a gain. The loss occurred where there were no root tubercles; it was especially large with oat and corn plants, and largest where they had the most nitrogen at their disposal in the form of nitrates. This loss may probably be due to the decomposition of the seeds and nitrates through the agency of micro-organisms. In brief, the acquisition of large quantities of atmospheric nitrogen by leguminous plants, which was first demonstrated by experiments here, and has been since confirmed by others is still further confirmed by the experiments herewith reported. These experiments in like manner confirm the observation of the connection between root tubercles and the acquisition of nitrogen. There is scarcely room for doubt that the free nitrogen of the air is thus acquired by plants."

Chemists, as a rule, hesitate to accept isolated cell life as modifying and conditioning the action of those more differentiated; yet it seems that all circumstances point to the fact that most reactions taking place between nitrogen and plants are influenced by micro-organisms.

Let us hope that chemistry will, in the near future, score its greatest agricultural triumph, by unveiling the mysteries which still shroud the specific actions of these organisms, thus making it possible to supply the demands of a constantly increasing population.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A course of instruction (Lectures and Laboratory work) in sciences bearing upon Agriculture will be commenced in Cambridge this term; it will extend over two years and will include the following subjects:—Agriculture; Chemistry, elementary and agricultural; Botany, elementary and agricultural; some departments of Physiology and Geology; Agricultural Engineering, Surveying, and Mensuration. Arrangements will also be made for instruction in Book-keeping, and in Agricultural Law for those who desire it. The subjects taken this term will be Elementary Chemistry, by Prof. Liveing; and Elementary Botany, by Mr. Seward, of St. John's College. It is hoped that this course will prove useful to gentlemen intending to farm, or to manage their own land, and to those who are likely to become estate agents. Further information may be obtained from Mr. H. Robinson, at the University Chemical Laboratory, Cambridge Prof. Foster announces a new intermediate course in Physiology, with laboratory work, especially for medical students, to be given by Dr. L. E. Shore, on Wednesdays and Fridays at ten, during the Michaelmas and Lent terms.

Dr. Donald Macalister, St John's, has been appointed Assessor to the Regius Professor of Physic.

Mr. S. F. Dufton has been elected to a Fellowship at Trinity College, and Mr. A. Hutchinson of Christ's has been elected to a Fellowship at Pembroke College, in each case for distinction in Chemistry. Both gentlemen took first classes in each part of the Natural Sciences Tripos.

Mr. J. Y. Buchanan, F.R.S., University Lecturer in Geography will deliver a course of lectures on Oceanography during the present Term in the New Museums, on Tuesdays at 12 o'clock, commencing on Tuesday, October 18.

Mr. W. C. D. Whetham, B.A., Fellow of Trinity College, has been appointed Assistant Demonstrator of Physics in the Cavendish Laboratory.

Mr. W. B. Hardy, M A., Junior Demonstrator of Physiology, has been elected to a Drosier Fellowship in Gonville and Caius College.

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[1] Z. Rub., xxv. I. 234.

[2] *Bied. Cent., Bl.*, xvi. 787.

[3] Cr. cvii. 397.

[4] N. Rd., iv. 201.

[5] *Bot. Ztg.*, xlvi. 725, 741, 757, 781, 797.

[6] Cr. cvii. 207, 852; cvi. 638, 1049, 1214.

[7] Cvi. 754, 944, 1098, 1174.

Amer. Chem. Jour., xii. 526; xiii. 42.